urchin *Melonites* (Lang, '96, ii, p. 291, Macmillan edition; and Dana, '95, Manual of Geology, p. 641) there are four, or in some genital plates five, pores, instead of one, as regularly in modern genera.

The positions of the ocular plates with reference to the border of the anal ring are subject to variation. The facts in the case are these: In a majority of the 65 *Arbacias* observed the plates are located exactly as shown in Fig. 1, where the madreporic plate meets its two neighbors by a long joint, thus pushing the ocular plate far away from the border of the anal opening, as compared with the left posterior ocular plate, which is only slightly distant from the border. The right posterior ocular and the right anterior are also less separated than the remaining two. This is the mode. The variations from it are on the part of the left posterior ocular chiefly and, in addition, of the right posterior, and less of the left anterior ocular plates. The extreme case of this variation is shown in No. 5, where the left posterior ocular plate participates in the formation of the border of the anal ring, as the right posterior also does, though in a less degree. In No. 21, the same variation is to be seen. Cases in which this form of variation takes place, but in a less extreme degree, are frequently met. No. 17 is such a case; here the left posterior ocular plate barely touches the margin; this is also seen in No. 3. In No. 10 this ocular does not quite reach the margin. The left posterior ocular thus shows a strong tendency to push itself into the anal ring, a tendency shown, too, but in a less degree, by the right posterior ocular and slightly by the left anterior ocular plate. The specimen of *Arbacia*, figured by Brooks in his 'Invertebrate Zoology' ('82, p. 86), which came from Southern waters, shows this same variation as to the left posterior ocular plate. The specimen of *Echinocidaris* (*Arbacia*) *pustulosa*, figured in Lang ('96, Macmillan, Comp. Anat., II., p. 232), shows the two posterior and the left anterior oculars all bordering the ring.

In some sea-urchins (*e. g.*, *Diadema*) all the oculars take a part equally in forming the boundary of the anal ring. In *Salenia*, believed to be a very primitive genus, none of them touch it. In *Strongylocentrotus* there is a condition between these two extremes; in that form the left posterior ocular and the right posterior ocular regularly form a part of the border of the anal ring, and occasionally the left anterior ocular reaches it. In *Arbacia* the corresponding ocular plates vary in the direction of an arrangement which is the mode in *Strongylocentrotus*. A somewhat extended study of the apical systems of *Arbacia* from widely separated localities, together with a similar study of that of some of the other sea-urchins, would probably be of considerable interest to students of variation.

HENRY LESLIE OSBORN.
BIOLOGICAL LABORATORY,
HAMLINE UNIVERSITY,
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INORGANIC FERMENTS.

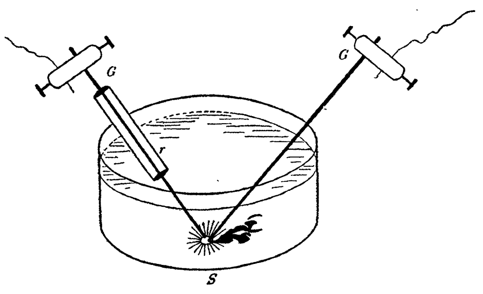
AN article on this subject appeared somewhat more than a year ago in the *Zeitschrift für physikalische Chemie* by Bredig and Müller von Berneck. Quite recently a monograph has been published by Bredig, under this title, containing an account of the experimental work which he has done with others and also an introductory chapter on colloidal solutions, method of preparation, etc.

The monograph begins with a discussion of the general properties of colloidal solutions. Graham found that colloids diffuse very slowly in comparison with crystalloids. Pfeffer showed that colloids exert very small osmotic pressures, and Tammann demonstrated that colloids lower the

vapor-tension of water to only a slight extent.

These facts can be accounted for in two ways, either by assuming that the colloids in solution have very large molecular weights or that colloidal solutions are not true solutions at all, but mechanical mixtures, in which the colloid is in a very fine state of subdivision. The latter view is now generally held for a large number of reasons, and for the metals, at least, seems to be made very probable by the method employed in the preparation of such solutions.

The work of Bredig and his pupils has to do with colloidal solutions of the metals, and the method employed in preparing such solutions is very interesting. Two bars of the metal in question are thrown into the circuit of a suitable electric current, and the lower ends of these poles are immersed in pure water, as shown in the figure. The



ends of the bars of metals, *g*, *g*, are brought sufficiently near that an arc is established between them beneath the water. The metal is torn off from the bars in such a fine state of division that it forms in the water a colloidal solution.

In such solutions the metal is so finely divided that it cannot be seen under the most powerful microscope, the solution appearing homogeneous under such conditions.

By the above method colloidal solutions of platinum, palladium, iridium, silver, gold and cadmium were prepared. These solutions had the properties of colloidal solutions in general, and it is quite evident that such solutions are but mechanical mixtures of the very finely divided metals with the solvent, water.

Such solutions of the metals have some quite remarkable properties, and one of these has been studied extensively by Bredig and his pupils.

It was found that colloidal solutions of platinum have the property of decomposing hydrogen dioxide catalytically. A catalyzer is a substance which, in relatively small quantity, can effect a large transformation. The solution of metallic platinum fulfilled this condition, a small amount of the solution decomposing a large amount of hydrogen dioxide. Bredig states that a gram, atomic weight of platinum in 70,000,000 litres of water can appreciably accelerate the velocity of the decomposition of hydrogen dioxide.

Further, in order that a substance may act catalytically, it must apparently not take part in the reaction which it produces, and must remain in an unaltered condition after the reaction is over. The colloidal solution of platinum also fulfilled this condition. Bredig has shown from a study of the velocity of the reaction, by a well-known method, that the decomposition of hydrogen dioxide by the finely divided platinum is a monomolecular reaction; *i. e.*, only one substance—the hydrogen dioxide—takes part in the reaction. The metallic platinum, therefore, does not enter into the reaction at all, but remains unchanged in the solution.

We now come to the most important part of the paper. The author sees an *analogy between the catalytic action of the colloidal platinum and the action of organic ferments.* They point out that recent work has shown that there are many reactions which are effected by both unorganized and organized ferments, and also by the contact

action of many metals and oxides of the metals. A few such reactions will be given :

Alcohol is oxidized to acetic acid by the oxygen of the air, both by the ferment mycoderma aceti, and by finely divided platinum. Calcium formate is decomposed into calcium carbonate, carbon dioxide and hydrogen, not only by certain bacteria, but also by finely divided iridium, rhodium and ruthenium. Dilute solutions of oxalic acid are decomposed by palladium platinum and silver sponge, and also by certain fungi, and the list of such reactions could be very greatly extended. From this it is obvious that analogies between the action of finely divided metals and organic ferments were not entirely wanting when the work under review was begun.

Bredig then attempted to determine how close these apparent analogies really are, by studying very carefully and thoroughly the decomposition of hydrogen dioxide by finely divided platinum.

It has already been pointed out that a very small amount of platinum can decompose a large amount of hydrogen dioxide, just as a small amount of a ferment can effect a large amount of chemical transformation.

It has also been shown that the finely divided platinum does not enter into the reaction, just as a ferment does not enter as such into the reaction.

The presence of electrolytes affects the colloidal condition of the platinum, and, consequently, its activity. They have the same influence on ferments.

But the most striking analogy between the action of these colloidal solutions of the metals and organic ferments is to be found in their conduct in the presence of certain poisonous substances.

Bredig and Reinders showed that hydrogen sulphide in very small quantity, can diminish the catalytic action of the finely divided metal. An akaline solution, containing one gram-atomic weight of sulphur in *ten million litres* of water, can produce an appreciable diminution in the catalytic action of the metal. Schönbein has shown that small quantities of hydrogen sulphide can appreciably diminish the action of organic ferments on hydrogen dioxide.

Bredig and von Berneck have shown that hydrocyanic acid has a remarkable influence on the catalytic action of platinum. Thus, one gram-molecular weight of hydrocyanic acid in *twenty million litres* of water diminishes to one-half the velocity of the decomposition of hydrogen dioxide by colloidal platinum. This again is strikingly analogous to the action of hydrocyanic acid on organic ferments. Schönbein showed that very small quantities of hydrocyanic acid very materially lessen the action of all organic substances which decompose hydrogen dioxide catalytically ; and quite recently Buchner has shown that hydrocyanic acid diminishes the action of the 'pressed juice' of yeast on hydrogen dioxide and on other substances.

The 'poisonous' action of a number of other substances, such as bromine, iodine, analine, arsene, arsenious acid, phosphene, phosphorus, carbon monoxide, oxalic acid, mercuric chloride, etc., on the colloidal platinum and on organic ferments was studied, with the result that a general analogy between the two was undoubtedly shown to exist.

The conclusion reached by Bredig as the result of this work can best be stated in his own words :

"All these facts point to an unmistakable analogy between the contact actions in the inorganic world, and the actions of ferments in the organic world. As, in the case of my colloidal catalyzers, we are dealing with reactions in which enormously developed surfaces are involved, so is it probable that the same condition obtains in the actions of ferments, enzymes,

blood corpuscles, and oxidizing and catalyzing organic substances. We see, therefore, that the organism develops its enormous surfaces in the tissues and colloidal ferments not only because it requires osmotic processes, but on account of the very great catalytic activity of such surfaces. If, as Boltzmann says, the war for existence which living matter must wage is a war about free energy, certainly, of all the forms of free energy the *free energy of surface* is the most important for the organism.

"In conclusion, I need scarcely state that I do not maintain that there is any mysterious identity between the metals and the enzymes. But, without exaggerating the overwhelmingly large number of analogies, we are compelled to regard the colloidal solutions of the metals, in many relations at least, *as inorganic models of the organic enzymes.*"

HARRY C. JONES.

SCIENTIFIC BOOKS.

Electric Lighting. By FRANCIS B. CROCKER, E.M., PH.D., Professor of Electrical Engineering in Columbia University, N. Y., and Past President of the American Institute of Electrical Engineers. New York, D. Van Nostrand Co.; London, E. & F. N. Spon.

This book is the second volume of a work, the earlier of which appeared in 1896. The complete work is intended to be a practical treatise on electric lighting for engineers, students and others. The prior volume dealt mainly with the establishment and equipment of electric lighting stations, including locations, buildings, power, dynamos, accumulators, switchboards, measuring instruments, lightning arresters, etc. The present volume, on the other hand, is devoted to that part of an electric light installation which includes the distribution of current and its utilization in various forms of lamps for light. As the author points out in his preface, the space available would not permit the more abstruse consideration of the several divisions of the subject, and this may well be admitted. A glance shows, indeed, that the volume has no waste space; the descriptions are brief, and the data compact and apparently quite accurate. In these respects it is excellent.

The book is eminently practical, but does not neglect the full consideration of principles necessary to a full understanding of the topics treated. It will be valuable as a reference book for engineers on account of the inclusion within its pages of many useful tables and examples.

Beginning with a chapter upon the physical properties of conductors, which includes the application, under limitations and modifications, of the so-called Kelvin's law, and the maximum carrying capacity, there follows a thoroughly adequate treatment of the various systems of electrical distribution in several succeeding chapters. The series systems, parallel systems, three-wire and five-wire distribution, direct current transformer systems and networks of electrical conductors, share the space alloted, in accordance with their importance in actual practice.

Chapters VII. and VIII. contain brief, but very lucid, expositions of the principles of alternating currents and polyphase currents respectively, after which follows a chapter devoted to a similar treatment of that very important adjunct, the alternating current transformer. The two succeeding chapters relate to alternating current systems of distribution and the calculation of such circuits. The matter appears to be well put together, and is amply elucidated by diagrams. The part of the work devoted to the distribution of delivery of energy to the place desired is concluded by a full and judicious consideration of overhead and underground conductors. Here may be found ample details of line construction, conduits, etc., as exemplified in the most recent construction, particularly in America.

The remaining portion of the volume proper is devoted to the utilization of the energy for lighting, as in arc lamps and in incandescent lamps, in addition to the accompanying interior wiring, and electric meters. The work concludes with appendices, one of which contains the National Electric Code of the Board of Fire Underwriters, and the report of the Committee